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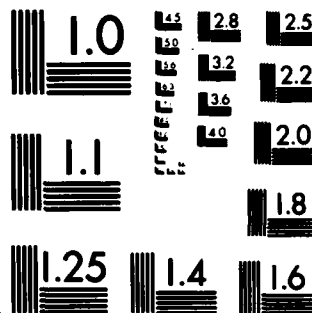
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**JOB-ORIENTED BASIC SKILLS (JOBS) CURRICULA:  
AN OVERVIEW OF FOUR RESEARCH STUDIES TO  
IMPROVE PROGRAM EFFECTIVENESS**

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) <p>The purpose of this study was to identify areas of instructional methods, techniques, strategies, or content that could be used to improve the program effectiveness of the job-oriented basic skills (JOBS) curricula. Subjects were lower aptitude students from a variety of settings. Four different study agencies administered four alternative strategies: schema-based studying, learned helplessness alleviation, instructional sequencing, and hierarchical displays. There were no significant results from any one study and</p>		

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results were ambiguous among themselves. It is concluded that the four studies merely set a foundation from which to conduct future research in the area of basic skills learning by lower aptitude students.

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## FOREWORD

This research was conducted under contract with the University of Illinois at Urbana-Champaign, Syracuse University, and University of Southern California. The research was in support of work unit Z1176-PN.03 (Improved Performance Through Instruction in "A" School Related Basic Skills). The purpose of this work unit is to determine whether a job-oriented basic skills (JOBS) training program can compensate for the skill deficiencies of lower aptitude personnel such that they can successfully complete Navy technical schools and perform to standards in the fleet.

This is the fifth report on the JOBS training program. Previous reports (NPRDC TRs 81-24, 82-14, 83-5, and 83-21) described program development and evaluation. This report is an overview of four research studies conducted to identify instructional methods, techniques, strategies, or content areas that could be used to improve JOBS program effectiveness.

The contracting officer's technical representative was Meryl S. Baker.

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## **SUMMARY**

### **Problem**

Currently, the attrition rate of job-oriented basic skills (JOBS) graduates is approximately twice that of "A"-school-qualified graduates (21 vs. 10%). Although this differential is accounted for in part by the fact that JOBS students have much lower aptitude scores and lower post-"A"-school-attrition rates than qualified students, methods to increase the effectiveness of the JOBS curricula are continually being sought.

### **Objective**

The objective of this effort was to conduct research that would identify instructional methods, techniques, strategies, or content areas that could be used to improve the JOBS program effectiveness.

### **Approach**

Four requests-for-proposal were funded to investigate alternate strategies that might be used to enhance the JOBS curricula.

### **Results**

Results among the four studies were ambiguous.

### **Conclusions**

The four studies conducted merely set a foundation from which to conduct future research in the area of basic skills learning by low aptitude students. It is clear that if significant resources were to be invested in the modification of the JOBS curricula, they would have to be justified by a far broader investigation resulting in less ambiguous results than the four studies presented in this report.

### **Recommendations**

It is recommended that:

1. Curriculum development personnel not alter the JOBS curricula at the present time.
2. Instructional research personnel use the studies presented in this report to delineate future areas of instructional research.

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## INTRODUCTION

### Background and Problem

The job-oriented basic skills (JOBS) program was conceived in 1977 in response to predictions that there would be a shortage of high quality accessions in the 1980s. High quality accessions are those individuals who score in mental categories I, II, or upper III on the Armed Services Vocational Aptitude Battery (ASVAB) tests. The purpose of the program was to determine whether mastery of job-oriented, basic/prerequisite skills training would provide lower aptitude students with the knowledge they needed to (1) complete selected "A" schools successfully and (2) perform to fleet standards on the job. Prerequisite skills training was developed for four "A" schools: Propulsion Engineering (PE), Operations (OPS), Administrative/Clerical (A/C), and Electricity/Electronics (E/E) (Harding, Mogford, Melching, & Showel, 1981).

Currently, the attrition rate of JOBS graduates is approximately twice that of "A"-school-qualified graduates (21 vs. 10%) (Baker & Hamovitch, 1983). Although this differential is accounted for in part by the fact that JOBS students have much lower aptitude scores and lower post-"A"-school-attrition rates than do qualified students, methods to increase the effectiveness of the JOBS curricula are continually being sought.

A recent evaluation of the JOBS program (Baker & Hamovitch, 1983) has shown that curricula improvements could potentially attenuate Navy technical shortages and contribute to minority upward mobility. Further, although aptitude differences may preclude JOBS students from ever attaining the "A"-school-qualified-student level, JOBS curricula improvements may enhance their subsequent "A" school and fleet performance.

### Objective

The objective of this effort was to conduct research that would identify instructional methods, techniques, strategies, or content areas that could be used to improve the JOBS program effectiveness.

## APPROACH AND RESULTS

Four requests-for-proposal were funded to investigate alternate strategies that might be used to enhance the JOBS curricula. A brief overview of each of these efforts, as adapted from the contractors' original reports, is presented below.

### Study 1 (Anderson, & Armbruster, 1982)

#### Purpose

The purpose of this study was to teach JOBS trainees (1) an appropriate higher order organizing scheme they could use to learn, remember, and use Navy technical manuals and (2) a systematic study strategy they could use in conjunction with the higher order, organizing scheme.

#### Hypotheses

This study is based on schema research that hypothesizes that (1) students can improve their learning from text after being taught basic text organizational patterns and

(2) study techniques are effective only if students use the schema techniques as an aid when processing important information in a meaningful, memorable form. The promising results of research in which students improved their learning from text after being taught basic text organizational patterns provided part of the impetus for the present investigation. It was thought that JOBS trainees would benefit from learning the organizational patterns of technical materials. In this study, the term "frame" refers to a higher order, general organizational scheme for a particular type of content. A frame has slots for the subcategories of content associated with it. A frame with its constituent slots can be instantiated by the information in a particular text that deals with the type of content covered by the frame.

### Procedure and Subjects

The first task identified a frame for the type of technical text that the JOBS students would be reading. Propulsion Engineering "A" school materials and associated rate training manuals were selected as representative. An extensive content analysis of these materials revealed that the content could be captured by a frame with the following slots: (1) name of the object (piece of equipment or part of a system), (2) main uses of the object, (3) parts of the object and their functions, (4) explanation of the operation of the object or how it works, and (5) problems that could occur with the object and how to prevent and/or solve them. The researchers named the frame OPPUN, an acronym standing for operation, parts and functions, problems and prevention/solution, uses, and name (OPPUN).

Based on a technical reading pretest, JOBS students who served as subjects were divided into two groups: experienced students (those who were in the JOBS curriculum program for 3 or more weeks) and new students (those who started the JOBS curriculum program that week). Pairs of pretest scores were used to randomly rank students into experimental and control groups. Ranking proceeded from the highest to the lowest pairs of scores, first from the experienced groups and then from the new-student groups. Four groups of students, matched for ability as measured by the pretest, resulted: (1) control-experienced students, (2) control-new students, (3) experimental-experienced students, and (4) experimental-new students.

Once the experimental versus control groups were formed, they were taught different learning strategies. The experimental groups were introduced to the OPPUN concept with which they used frames to focus on important information. The control groups were taught a Main-Idea strategy with which they underlined main ideas and recorded them in the form of notes. Both the experimental and the control groups were given ample time over a period of days to practice their respective study strategies.

### Findings

Results indicated that the OPPUN study strategy seemed to facilitate the new students in the parts section but was detrimental in the operations section. In contrast, the OPPUN strategy facilitated the experienced students in the operation section but was slightly detrimental in the parts section. In addition, the experienced students who used the OPPUN strategy scored substantially higher than their Main-Idea-control group or their new-student-comparison group. The OPPUN group scored 24 percent higher than the Main-Idea group on the uses content and 162 percent higher on the problem-solution content. In a sense, the pattern reflected by the experimental students supported the hypothesis that the OPPUN strategy, when compared with the Main-Idea strategy, would result in more facilitative learning outcomes.

An unusual attrition pattern caused interpretation problems. Even at the beginning of the experiment, there were not very many students available. The attrition problem was most pronounced with the experienced students in the OPPUN strategy group. Initially, this group was the largest with 11 students. However, by the third training session, there were only four students--the same four who took the final exam. This represents a 64 percent attrition rate for this group, whereas none of the other three groups experienced nearly as large a loss.

The attrition problem suggests an alternative explanation of the results, which showed that the OPPUN group performed better on the posttest than did the Main-Idea group. That is, the strategy treatment may have had nothing to do with the difference; rather, those students who dropped out of the experiment were perhaps the less intelligent ones who needed the night study sessions to do remedial work. The four students who remained in the study were perhaps brighter than those who remained in the Main-Idea group. To test this hypotheses, pretest scores of the students in these two groups were compared. A comparison of means showed a difference in the hypothesized direction (27.2 compared with 24.2), but the difference was not significant,  $t(12) = 1.079$ ,  $p > .30$ . Therefore, the hypothesis that the groups who actually took the posttests would differ in reading ability was rejected.

The data suggest that the OPPUN strategy worked better with the JOBS students who had been in the JOBS curriculum for at least 3 weeks (experienced students) than it did with the new students. This may be a result of the JOBS training already received by the experienced group. Perhaps the exposure to other types of learning strategies during the JOBS course enhanced their ability to employ the OPPUN strategy.

Certainly the findings are too tentative to suggest that the OPPUN strategy be incorporated into the JOBS curriculum. More research at several levels is needed before such a decision can be made.

## **Study 2 (Keller, 1982)**

### **Purpose and Hypothesis**

The purpose of this study was to test an instructional design strategy that would help eliminate the interference effect of "learned helplessness" on the acquisition of basic skills by low aptitude students. Learned helplessness is a phenomenon created by a perceived independence between response and reinforcement. It develops when an organism is repeatedly subjected to situations in which it is motivated to succeed, but it is in fact helpless to do so. Once the perception of helplessness is established, it persists into situations in which success is possible. The development of a learned helplessness attitude results in low expectancy for success. This becomes a self-fulfilling prophecy for students who continue to fail despite having had, at times, a real desire to succeed.

### **Subjects**

The trainees in the JOBS program would seem to have "learned helplessness" characteristics. They were low aptitude persons who typically had a sense of failure in regard to school-related subjects, such as math and reading. Furthermore, it was difficult to distinguish between a lack of native ability versus years of low achievement as causes of low measured ability. To test the assumption of a learned helplessness factor among JOBS trainees, subjects were subjected to an instructional strategy designed to alleviate

learned helplessness. It was conjectured that, if such a treatment were successful, it would support the inference that a learned helplessness condition was present among these learners.

JOBS students were unavailable for participation in this study. Subjects were instead drawn from a group of recruits who scored below the 6.4 reading grade level on the Gates-MacGinitie Reading Comprehension Test administered by the Navy and, hence, had been referred to the academic remedial training (ART) program.

### Procedure

Subjects were administered the reading interest survey (Keller & Keller, 1981), used to measure values, expectancies, and attributions, and Level II of the wide range achievement test (WRAT) (Jastak, J. S. & Jastak, F., 1978), used to assess recognition and naming of letters and pronunciation of words out of context.

Subjects were divided into two groups: reattribution treatment and success only. The reattribution treatment group completed four instructional segments in reading, were administered WRATs following each segment, and were given both positive and reattributional feedback. Hence, the students in this group were not only praised for their performance but they were also counseled that any good performance was a direct result of their efforts and not of some external environmental factor. The success-only group received only positive feedback after they successfully completed an instructional segment in reading and during the WRAT readministration.

Upon completion of all reading instruction and the fourth administration of the WRAT, both groups were administered the Peabody Individual Achievement Test (PIAT) (Dunn & Markwardt, 1970), which included vocabulary and comprehension subtests, and the Krodman scale of self-esteem,<sup>1</sup> and were readministered the reading interest survey.<sup>2</sup>

### Findings

Results offered additional confirmation of a basic alleviation strategy for learned helpless attitudes among low aptitude, or at least measured low aptitude, learners. The study also offered support for a general expectancy-value theory explanation of the motivational effects of the strategy, and it appeared to illustrate the effects of the strategy on personal attributions as predicted by a reformulated theory (Abramson, Seligman, & Teasdale, 1978). The subjects in the reattribution group showed a greater shift toward internal attributions and they definitely improved their performance. By inference, the effectiveness of this strategy seemed to help confirm the presence of a learned helplessness attitude among learners who had been consistent failures.

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<sup>1</sup>Keller, J. M., & Keller, B. H. Development of parallel self-report and teacher report measures of student motivation for specific school subjects. New York: Syracuse University, Instructional Design, Development, and Evaluation Program. Occasional paper, 1981.

<sup>2</sup>Krodman, D. A. Negative effect, self-esteem deficits, and the internality of attributions associated with helplessness (Unpublished doctoral dissertation). New York: Syracuse University, 1980.

Learned helplessness appeared to be a difficult condition to reverse, particularly when it had been generalized to many different facets of a particular skill area (Seligman, 1976). The present study had a positive influence within a short time, but it was impossible to know whether this influence generalized beyond the experimental setting. Even in this short time span, several important conditions were observed. First, it was not easy to provide an instructional unit of work at the appropriate level of challenge, especially in reading. The ART program helped make this possible because of the detailed pretesting that was conducted and the instructional program that was coordinated with the skills covered on the pretest. In a typical classroom, it might be even more difficult to provide an instructional unit of work at the appropriate level of challenge because of a greater degree of heterogeneity among the students and an inability to manage the number of subgroups that would result.

Another factor that influenced the practical significance of results was the testing and feedback. A student must be tested soon after honest effort has been exerted, and the feedback must follow immediately after the testing if the results are to be significant. This is another situation that is difficult for the typical instructor to manage. Although instructors could offer supportive, concerned feedback, they could not do so on a precise schedule because of multiple demands on their attention during any given class period. Military instructors, particularly, tend to have rather large classes for short periods of time, especially in "academic" subjects. Alleviation would be easier to implement in small classes, such as the skill development classes in which an instructor works closely with a small group of trainees.

#### Limitations of the Study

There were several limiting factors in this study. First, the general environment in ART appeared to be so supportive from a motivational standpoint that it may have interfered slightly with the effects of the treatment. The nature of the interference was, presumably, positive as it may have elevated the posttest measures of both groups. This is desirable from an ethical point of view, but it may have contributed to a type of "ceiling" effect here.

A second problem concerned the revolving nature of the procedure. The subjects from both the reattribution and the success-only groups freely mingled in their classrooms at lunch and after classes. This could have introduced a biasing effect, even though the informal observation of the experimenters did not reveal such biasing. The experimenters talked with the subjects and the instructors at the end of their participation in the study. In no case were these persons aware of, or even particularly inquisitive about, the critical features of the study. They wanted to know the general purpose, how it was being conducted, and what its effect would be on the recruits, but none of this seemed to have led to a specific source of confounding. It could, however, have led to a general Hawthorne effect. The presence of the investigators and the nature of the study may have contributed to a heightened sense of arousal, and that may have accounted for some of the changes in both groups, but it would not seem to have had a biasing effect on the differential treatment results. Even so, it would be beneficial to conduct the study under conditions in which there were no reactive effects due to the presence of an unfamiliar "experimenter."

One other limiting factor that should be mentioned is that the study conducted entirely with males limits its generalizability. There is no particular reason to believe that the strategy would work differently or less well with females, as a prior research study found no sex differences in this area. However, this will have to be considered as a limitation until there is a broader base of support for the strategy.

### Study 3 (Reigeluth, 1982)

#### Purpose and Hypothesis

The purpose of this investigation was to examine the effect on performance of various sequence and synthesis approaches to basic skill instruction. Four sequence (forward chaining, backward chaining, hierarchical, and elaboration) and two synthesis (performance synthesis and contextual synthesis) techniques were investigated, definitions for which are given below. Sequence and synthesis techniques were hypothesized to be of varying effectiveness, depending on length of task to be learned. Hence, four tasks of varying lengths were investigated. Tasks were in the math and English subject areas.

#### 1. Sequence Techniques.

a. Forward chaining. This form takes the results of an information processing task analysis and sequences the steps in the order in which they are performed. That is, the step that is performed first is the step that is taught first. The rationale for this sequence is the logic of the correspondence between the performance sequence and the learning sequence.

b. Backward chaining. This form (Gilbert, 1962) takes the results of an information processing analysis and sequences the steps in the opposite order from that in which they were performed. That is, the step that is performed last is the step that is taught first. All the necessary inputs from prior steps (which have not yet been taught) are provided so that the student can actually practice performing that step. The rationale for this sequence is that the completion of the task is far more intrinsically rewarding to the student than the completion of some intermediate step. A backward chaining sequence is designed to result in greater reinforcement, which in turn should improve learning. It also seems likely that a constant awareness of the goal or purpose or outcome of what is being learned provides more meaningfulness and motivation.

c. Hierarchical. This form takes the results of a hierarchical task analysis and sequences them in a bottom-up order. Ordinarily, the sequence starts with the left-most skill on the bottom of the hierarchy and proceeds to the right until all of the skills that are subordinate to a single, higher level skill have been taught. The rationale for the hierarchical sequence is that lower level skills are components of the higher level skills and therefore must be learned before the higher level skills can be learned.

d. Elaboration. This form is based on the results of both an information processing analysis and another form of analysis called path analysis. This kind of sequence is only used for a rule that has at least one decision step and hence at least two or more branches. Path analysis entails the identification of all possible "paths" (or distinct combinations of steps) that could be used to perform the rule. Then the shortest path is taught first, usually in forward chaining sequence. Also, each step in that path is always preceded by any prerequisites that were revealed by a hierarchical analysis of it. Then the next shortest path is taught in the same manner, and so on, until all of the paths have been taught. The rationale for this sequence is that the learner is actually able to perform the whole task (albeit under the simplest possible circumstances) from the very first lesson.

#### 2. Synthesis Techniques.

a. Contextual. This form shows how the various pieces of content fit together. In the case of rules, it shows the order among the steps or operations. Contextual

synthesis is usually presented before the related application-level instruction, although it may come after. At the very beginning of the instruction, it may show the relationships between the rule that is about to be taught and similar rules that have already been taught, in which case it is usually called "external" synthesizer. Otherwise, it shows where the step (or set of steps) that is about to be taught fits within the whole rule that is being taught. In this case, it is usually called an "internal" synthesizer.

b. Performance. This form is intended to help the student to perform the whole rule smoothly, without hesitation and with full recall of which step comes when. It is not enough for students to simply learn all the individual steps; it is essential for them to know when to use and when not to use each step in relation to all the other steps. Performance is a habit that comes through practice. Hence, performance synthesis always comes after the application-level instruction, and it always includes "integrated" generalities, examples, and practice. Integrated generalities describe the order in which to use all the steps taught so far in the instruction, including when to use and not to use each. Integrated examples show the use of all those steps to solve a specific problem, and it shows them all being used back-to-back. Similarly, an integrated practice item requires the use of all those steps to solve a specific problem, and it requires that they be used back-to-back.

#### Subjects and Procedure

As JOBS students were unavailable, college freshmen enrolled in a remedial algebra course or in a basic English course served as subjects. Subjects were primarily remedial learners rather than first-time learners. In other words, the purpose of the study was to review skills that the learners had already been exposed to, rather than to teach completely new skills. This difference may have influenced the effects of both contextual synthesis and sequence. Since the student needed review but received primary instruction, the results of this study may be entirely different from what they would have been if the students had been first-time learners. However, for purposes of generalization to Navy JOBS students who are remedial learners, this problem was of no concern.

#### Methodological Concerns

Subjects lacked familiarity with the different instructional sequences and this could have had a negative impact on both achievement and effect of results. Some students initially expressed considerable confusion over the backward chaining sequence. The same may also have been a factor in the elaboration sequence and, to a lesser extent, in the hierarchical sequence. Thus, lack of familiarity likely had differential effects across all treatments, with the particular detriment of all sequences except forward chaining.

The nature of the math test given and the experimental situation worked to reduce any differences that might otherwise have resulted from the treatment effects, although the math test was that normally used in the remedial algebra course and was not an ideal measure. First, the number of items for each task was quite small, which impeded the test's ability to discriminate among levels of achievement. Second, the test did not measure the full range of skills that had been taught. Many types of problems, particularly the more difficult ones to which the rules taught, were not included on the test and reduced the test's ability to discriminate among different levels of achievement. It was considered unfortunate that the experimental environment precluded administration of a test created by the researcher.

In the experimental situation, there was a considerable time gap between the administration of the treatments and the test. During the time gap, students were allowed to take their booklets home and study them. It is possible that they compared



their booklets with those of other students. Further, and perhaps even more important, a student could reread his booklet in any sequence, which precluded his having received a true implementation of his instructional sequence because he had already read steps that appeared later in the booklet. It would have been far superior to have administered a test immediately after the students had first studied their booklets from beginning to end.

A final set of methodological concerns were related to the English experiment. The task was "how to write an argumentative essay," and the achievement measure was a student essay. All essays were "blind" rated on a scale from 1 to 10 by at least two experts--the section instructor and the instructor of another section of English 101. ("Blind" meant that none of the raters was aware of the ratings of any of the other raters.) The two ratings differed by more than 3 points in over 50 percent of the essays. In all such cases (two ratings that differed by more than 3 points), another rater provided a third blind rating. Even though the only criteria used in the ratings were those that were taught by the treatment materials, the ratings were poorly correlated. It was also found that instructors rated class essays consistently higher than did the outside rater. This lack of an objective and reliable measure of achievement made it very difficult to assess the reliability of differences.

It is important to note that the general ability level of Navy JOBS students is lower than that of the present study participants. However, it should also be noted that there were no interactions between ability level and any of the factors investigated in this study. Since the range in SAT scores in our sample was considerable (300-710), this lack of interaction provides some support that findings may be generalizable to the Navy JOBS students.

### Findings

The results of this study indicated that the effects of both sequence and synthesis techniques varied directly with the length of the task to be learned, with absolutely no effect on short tasks. Also, the forward chaining sequence resulted in higher performance achievement than did the elaboration sequence. No other significant effects were found.

Several interpretations may be suggested by the results. First, it seems likely that there was a certain minimum quantity of interrelated procedural content, above which an elaboration approach was the only viable way to go, but below which the elaboration approach did not function as well as alternatives. Several factors may have influenced why this approach was dysfunctional below a minimum quantity of procedural content. One is that students were confused when, for instance, four steps were taught as a stand-alone rule in the first lesson and other intermediate steps were taught in later lessons, such that what was step 3 in lesson 1 became step 7 in lesson 2, and so forth. This awkwardness in numbering is unavoidable in an elaboration approach, unless steps are not numbered at all.

Another factor that may have accounted for the elaboration approach being dysfunctional below a minimum quantity of procedural content was the nature of human learning. Spatial and chronological cues may be powerful aids to learning. For example, when a person wishes to find some information that has been read fairly recently, he or she may remember that the information was on the top of a right-hand page. It is likely that such a spatial cue was encoded in what Gagne and White (1978) referred to as the image memory store. In a similar way, a sequence of events (which is characteristic of any role) is believed by the same theorists to be stored in the episodic memory store. These are in contrast to intellectual skills that are believed to be stored mainly in the propositional

memory store. It seems quite possible that episodic memory may have a limit in terms of the size of a rule that it can comfortably handle at a given time. That is, if the memory limit is exceeded, then it becomes necessary to "internalize" that rule with it being passed to the propositional memory store, which is organized hierarchically (or subsumptively). The episode memory then benefits from a subsumptive or elaborative sequence (i.e., a simple-to-complex or general-to-detailed sequence). If this interpretation is correct, then an important area for future research would be to determine the critical size below which a forward or backward sequence would be optimal and above which an elaborative sequence would be optimal.

### Recommendations

Given the current state of knowledge, the major implications of this and other related research for the design of instruction around intellectual skills in general and on basic skills in particular are as follows.

1. Identify (through an information processing task analysis) all rules that need to be taught. Be sure to combine all related rules into a single large rule, with the result being several large rules.

2. Decide if the total amount of instruction required to teach each single large rule exceeds approximately 20 hours. If it does not exceed 20 hours, then use forward chaining (without contextual synthesis) to sequence the instruction.

3. If the total amount of instruction exceeds 20 hours, then use an elaboration sequence. However, the elaboration theory currently proposes that each "lesson" in the elaboration sequence be limited to about 1 hour's worth of instruction. This research suggests that each "lesson" should supply at least 10 hours, or more, worth of instruction. This would probably allow for an entirely independent branch of a rule to be taught in each "lesson," such that the problem of a student having to renumber steps would not be encountered.

4. Within each "lesson" (10 hours or more worth of instruction), a forward chaining (with contextual synthesis) or a backward chaining (without contextual synthesis) sequence should be used.

5. Do not bother to use either contextual or performance synthesis within any "lesson." Rather, use them at the beginning and end of each "lesson."

### Study 4 (Allan, & Merrill, 1982)

#### Purpose

The purpose of this study was to explore, on a theoretical level, the use of several aptitude approaches to predict the degree of external support required by learners. On an empirical level, the study attempted to demonstrate the feasibility of moderate aptitude students being guided in the selection of learning strategies appropriate to a specific learning task.

#### Subjects

Because JOBS students were unavailable, subjects were selected from an area other than the targeted population. Subjects were from a continuation high school in Fullerton, California. The degree to which the skill and knowledge level of these students reflected that of the JOBS student population was not discussed by the investigators.

## Procedure

The study focused on a direct comparison of system-assigned and student-assigned strategies, with attempts to control for differences in aptitude. System-assigned strategies are those that are delivered over a separate, independent variable information channel and that exclude specific reference to subject-matter content. Three strategies implemented in this study were those for (1) choosing examples and nonexamples, (2) remembering the critical attributes of each concept, and (3) reviewing concept definitions. Student-assigned strategies are to be utilized by the student without system guidance. The student has complete freedom to select examples and nonexamples in any pattern.

A second focus was a comparison of tabular and hierarchical presentations of information. In an hierarchical display, the critical attributes required to make classification decisions are represented in the form of a hierarchy. Attributes are represented in the form of a network, which shows the relationship of all attribute nodes and branches. In a tabular display, the critical attributes required to make classification decisions are represented in the form of a table. Such a display provides the information contained in each node but detaches the nodes from the hierarchy and represents them in a serial, nonbranching pattern. The classification scheme used in this study is loosely based on the imaginary science of Xenograde Systems (Merrill, 1965). As implemented in this current extension of the original Xenograde "curriculum," the scheme groups imaginary particle systems into 10 letters of the alphabet order to control for rote memory effects.

Subjects included two experimental groups and one control group, all of whom were required to learn pseudo-concepts instructionally presented via an Apple II micro-computer. Subjects in the first experimental group were presented instruction in tabular form and the computer system assigned learning strategies. The second experimental group was presented with instructional information in hierarchical form and the group selected their own learning strategies. The control group was presented instruction in tabular form and the group employed their own learning strategies.

## Findings

Results indicated that the direction of differences between group means was consistent with the hypothesis that system-assigned strategies can enhance acquisition of coordinate concepts. As an empirical study, the investigation produced tentative evidence that it is possible to transform a conventional instructional strategy based on examples and nonexamples into an equivalent system-assigned learning strategy in which students are guided in the selection of their own examples and nonexamples.

The study encountered two major methodological problems, both of which were traced to the use of continuation school students as subjects. The first problem was that inadequate control of individual difference variables resulted in excessive error variance. Although much of this within-group variance was clearly attributable to differences in prior academic achievement, statistical control of these nuisance effects proved infeasible because of the complex interaction of achievement variables with the experimental treatments. It was suggested that this problem be corrected with the use of a more homogeneous subject pool or with the use of statistical controls that would partial out the effect of the interactions.

The second problem was that the low achievement level of many of the subjects may have violated the crucial requirement for the predicted success of the system-assigned strategies. The locus-of-processing continuum prescribed embedded treatment for low aptitude students. Therefore, a factor that may have contributed to the lack of a

significant treatment effect of the system-assigned strategy was that it inappropriately intervened for some of the students. It was suggested this problem be rectified with the use of subjects who have moderate achievement levels. Prior achievement in mathematics appeared to be an excellent predictor of the ability to apply the system-assigned strategies used in this experiment.

There were no significant differences in the posttest performance of groups who used the hierarchical and tabular displays. Perhaps the most surprising result of this study was the small magnitude of the treatment effect. It is unlikely that the lack of a significant effect for the conceptual hierarchy was due to error variance alone. The difference between treatment and control means was negligible. A more likely explanation would be that the hypothesized positive effect of the hierarchy as an expository aid was confounded with a negative effect when the hierarchy was used for practice in instantiation definitions.

### Recommendations

The value of this study goes beyond specific experimental methodologies and results. It serves as a small-scale illustration of some of the practical benefits of microcomputer-administered research. For example, the classification training involved procedures that were far too complex to implement through other media with any consistency, yet subjects required a minimum of supervision to operate the systems. The computer displays themselves (and perhaps their billing as a video game) appeared to maintain subject attention and motivation at high levels throughout the experiment. Data indicate that the computer-administered classification test was an extremely reliable instrument for use with college and high-school subjects alike.

### CONCLUSIONS

It is rare that any one research study can significantly influence instructional practice. The four studies reported herein merely set a foundation for future research in the area of basic skills learning by low aptitude students. It is clear that, if significant resources were to be invested in the modification of the JOBS curriculum, the justification must come from a far broader investigation resulting in less ambiguous results than the four studies presented in this report.

Since the JOBS program curricula were developed with the use of the most current instructional development methodology, it will probably be some time before enough significant research is conducted and synthesized to warrant modification of the curricula for significant impact on program effectiveness. When and if such research becomes available, the question of curricula modification should again be addressed.

### RECOMMENDATIONS

It is recommended that:

1. Curriculum developers do not alter the JOBS curricula at the present time.
2. Instructional research personnel use the studies presented in this report to delineate future areas of instructional research.

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